RCRA TRIAL BURN TESTS, TOOELE ARMY DEPOT DEACTIVATION FURNACE, 9-31 August 1993

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ABSTRACT

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TOOELE ARMY DEPOT (TEAD) DEACTIVATION FURNACE
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The test objectives were to determine if the deactivation furnace met the performance standards for hazardous waste incinerators (HWIs), and to establish operational limits required for a Resource Conservation and Recovery Act (RCRA) Part B Permit for the furnace.

The waste feed mixtures were unique to these tests. The selection of these mixtures was used to provide adequate simulation of a broad range of munitions and propellants which would be incinerated in the deactivation furnace.

The deactivation furnace met the performance standards for particulate and principal organic hazardous constituents except the destruction and removal efficiency (DRE) of hexachlorobenzene (HCB). One of the three HCB runs failed to meet the required 99.99 percent DRE. The corrected carbon monoxide (CO) 1-hour rolling average for all tests conducted was below the Tier I limit of 100 ppm. The chromium (Cr) emissions exceeded the Tier II metals emission limit for all metals runs. The lead (Pb) emissions exceeded the Tier II metals emission limit for nine of the eleven metals runs. The cadmium (Cd) emissions exceeded the Tier II metals emission limit for one of the eleven metals runs.

The upgraded deactivation furnace at TEAD is the first DESCOM installation furnace which has been tested under the present standards. Upgraded furnace systems at two other Army Ammunition Plant sites have been tested under these same standards, one at Lake City AAP and the other at Iowa AAP. However, the waste feed at those sites was site specific. Thus the

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results of these tests oannot be directly correlated to the TEAD furnace tests.

INTRODUCTION

A Part B permit is required under RCRA for the operation of hazardous waste incinerators. The Army has been involved in upgrading facilities and performing trial burns to obtain Part B permits for the furnace operations. The TEAD Ammo Mission furnace as one of the upgraded sites has been involved in mini-burn tests and trial burn tests beginning May 1993. TEAD was granted a Part B permit in March 1993 which allowed the furnace to prepare for trial burn tests which, if passed, would allow the facility to operate and dispose of hazardous waste as specified in the Part B permit.

BACKGROUND

The basic APE-1236 military deactivation furnace, of which the TEAD Ammo Mission furnace is typical, is used to incinerate explosives and munitions. The key part is a rotary kiln, 20 feet long, 3 feet in diameter, composed of four retort sections. The 5-foot sections are cast from ASTM A217 Chromium-Molybdenum steel, the two end sections being 2.25 inches thick and the two center sections being 3.25 inches thick to withstand explosions within the kiln. An internal spiral flight, which is an integral part of the casting, advances the feedstock through the kiln as it rotates. The flights vary in height with the highest part in the middle, tapering down toward both ends. The flights also help mute the shock wave when a feedstock item detonates, and minimizes propagation of the detonation to other items separated by the flights.

DESCRIPTION OF THE UPGRADED SYSTEM

FACILITY DESCRIPTION

The upgraded deactivation furnace system consists of a Waste Feed Monitoring System (WFMS), dual conveyor feed system, rotary kiln, discharge conveyor, afterburner, high and low temperature gas coolers, cyclone, baghouse, draft fan and exhaust stack. The entire furnace is enclosed in a steel shroud. A number of sensors (temperature, gas flow, pressure differential, combustion gases composition, etc.) are used to monitor operating conditions at various locations in the system. Signals from these sensors are monitored by a data acquisition system (DAS) which constantly compares the operating conditions to preset operating standards.

WASTE FEED MONITORING SYSTEM

The WFMS controls the furnace feed rate. The WFMS consists of a box two feet long and eight inches wide with a push off system. The box is mounted over the primary waste feed conveyor twenty feet from the furnace feed chute. A weighing system is used which prevents overloading the furnace. The feed rate is dependent on the type of munition being incinerated. The munition type must be entered into the computer before the waste is fed to the furnace. The computer reads the weight of the munition and pushes off the munitions if the munitions are equal to or less than a preprogrammed maximum allowable weight. The push off system will not activate if the weight exceeds the maximum weight limit.

FEED CONVEYORS

The primary waste feed conveyor transports the munitions from the WFMS to the short conveyor. The short conveyor transports the munitions into the feed chute. The conveyor is covered by a shroud to prevent loading of munitions directly and bypassing the WFMS. Both conveyors have the flights spaced 18 inches apart. The short conveyor is implemented as a safety precaution. When an emergency situation arises, the primary waste feed conveyor shuts down while the short conveyor continues to operate. This allows munitions near the high temperature end of the kiln to continue moving through the furnace and deters possible explosions outside the furnace.

ROTARY KILN

The rotary kiln was designed to destroy, by incineration, small ammunition or explosive end items and bulk explosive or propelling materials. The rotary kiln is also referred to as a retort or as having retort sections. The retort is 20 feet long with an average internal diameter of 30.5 inches. The rotary kiln walls are designed to contain any abnormal detonations. Also, the furnace is barricaded by concrete enclosure designed to contain the effects of a high-order detonation. Internal spiral flights propel the waste through as the kiln rotates and also separate the munitions. This discourages sympathetic propagation of detonations and defeats any fragments generated by detonations. The kiln is equipped with a variable speed drive which allows it to rotate at different speeds, ranging from 0.5 to 3.0 rpm.

The burner is a proportioning burner consisting of a #2 fuel oil burner with bracket and mounting plate, oil pressure regulator and shut off valve. Combustion air is provided by a low pressure centrifugal blower and by air induced through the metal-parts discharge opening and the annular openings where the retort enters the feed and discharge housings.

FUGITIVE EMISSIONS CONTAINMENT

The entire furnace system is enclosed in a steel shroud. The shroud is approximately 8 inches from the furnace exterior. The shroud, acting as a floating skin for the deactivation furnace, confines the fugitive emissions from the furnace. These emissions are removed through three fugitive emission return ducts. The ducts are held under negative pressure by the burner blower which routes the emissions back into the furnace.

DISCHARGE CONVEYOR

Metal components of end-item munitions and ash are discharged from the furnace onto the discharge conveyor. The discharge conveyor transports the waste through the reinforced concrete barricade wall to a collection point outside the wall.

AFTERBURNER

The afterburner is designed to raise the temperature of the exhaust gases exiting from the kiln. This elevated temperature and the added residence time enhances the complete combustion of the explosive. The afterburner is capable of heating 4,000 scfm of air at 400-900° F up to 1200-1600° F with a minimum residence time of 1 second. The afterburner is mounted above the furnace retort and fits directly into the 24-inch duct exiting from the rotary kiln. The afterburner uses a Hauck Wide Range Burner consisting of a combination liquid propane and #2 fuel oil burner with bracket and mounting plate, oil pressure regulator, edge plate filter and shutoff valve.

GAS COOLERS

The gas coolers are cross current heat exchangers with ambient air as the cooling medium, and are designated the high temperature heat exchanger and the low temperature heat exchanger. The hot exhaust gases enter the inlet plenum of the cooler and pass alternately downward and upward through the first and second sections and then exit through the outlet plenum. Ambient air is forced through the cooling chambers by a blower. The heavier particles fall out of the gas stream in the coolers due to pressure drops in the Air Pollution Control System. Particles are cleaned from the plates by using a sonic horn. The particles are discharged from the cooler via a double tipping valve into a sealed 55-gallon container. The cleaning of the heat transfer surface area and the discharging of the residue are automatic, continuous processes.

CYCLONE

Large particles from the gas stream are removed by the cyclone. The cyclone has a clock-wise rotation, with inlet and outlet ducts at 90° separation. The pressure drop across the cyclone is designed at 2 to 5 inches water gage. The separated particles fall into a collection hopper. Discharge from the collection hopper is through an airtight, double tipping valve.

BAGHOUSE

The baghouse is a fabric-filtration collector, used for final particulate cleansing of the gas stream. The baghouse contains 100 bags which are 4.5 inches in diameter and 8 feet long. This gives a total filter area of approximately 950 square feet and an air to cloth ratio of 5.0. The bags are Nomex felt and are silicone treated, heat set, and flame proofed. The dust laden gas stream enters the baghouse near the bottom of the hopper where it is dispersed evenly along the rows of bags. Dust particles are deposited on the filter bags as the gases pass through them. The baghouse uses the pulse-jet cleaning method. The particles settle into the hopper below and are exhausted through a double tipping gate valve into a sealed 55-gallon drum while maintaining an air seal on the baghouse assembly.

DRAFT FAN

The gas steam is pulled through the APCS by an induced draft fan. The fan is capable of pulling 6700 actual cubic feet per minute at a draft (negative pressure) of 30 inches wg at the fan inlet. The total system pressure drop is approximately 25 inches wg.

EXHAUST STACK

The A36 carbon steel, circular exhaust stack is 30 feet high and has an inside diameter of 19.25 inches.

DATA ACQUISITION SYSTEM

The system controller has the capability to control furnace operations in a programmed sequence, make decisions based on sensor input, and provide a totally automated furnace operation. The control configuration includes the following items:

a. A 386DX Computer, 4MB RAM memory and 240MB hard drive.

b. Standard AT keyboard, industrially hardened and designed to mount in the front panel of an enclosure.

c. High resolution color graphics monitor.

d. A PID loop analog controller which is capable of automatically calculating the optimum tuning parameters and entering the parameters into memory. It provides digital input allowing remote setting of setpoints and selecting Auto/Manual operation.

e. A line printer which is capable of a minimum of 180 characters per second draft mode and 60 characters per second letter quality mode.

f. A strip chart recorder which is capable of recording a minimum of 14 channels simultaneously.

g. A programmable logic controller which is capable of supporting isolated 120 VAC outputs, 24 VDC inputs, thermocouple inputs, 4-20 mA, 0-10 VDC inputs, and 4-20 mA, 0-10 VDC outputs.

A full compliment of programming instructions including counters, timers, relays, sequencers, file functions, but functions and math functions. The programmable logic controller is capable of transmitting and receiving bi-directionally via an RS 232/422 serial link. This data communication takes place between the programmable logic controller and the computer.

MINI-BURN TESTS

In preparation for the RCRA Trial Burn Tests, an abbreviated tests series, mini-burn, was performed in May 93. The purpose was to evaluate emissions from the TEAD furnace, compare these emissions to the Trial Burn requirements of both the Resource Conservation and Recovery Act (RCRA) and the Utah Division of Solid and Hazardous Waste, and evaluate deactivation furnace operations. Another objective was to assure readiness and identify problems prior to a full scale RCRA TB.

Two 1 hour test runs were made with no waste feed with metals emissions being measured. Three 2 hour runs were made with M1 Propellant/HCB/metals mix with particulate, metals, HCB, CO and total hydrocarbons (THC) emissions being measured (see table below).

Avg Waste Feed Rate (lb/hr)	**Run 3 14 May 93**	**Run 4 17 May 93**	**Run 5 18 May 93**	**AVG**
M1 Propellant	108.9	120.60	150.00	126.5
HCB	2.18	2.41	3.00	2.53
Lead Shot	417.45	462.30	575.00	484.92
Antimony Trisulfide	5.08	5.63	7.00	5.90
Barium Carbonate	31.29	34.65	43.10	36.35
Chromium Powder	0.0280	0.0310	0.0385	0.0325
Lead Nitrate	8.06	8.92	11.10	9.36

The furnace met the particulate standards for HWIs. The corrected particulate concentrations for all test runs were below the 0.080 gr/dscf standard.

The corrected CO 1-hour rolling average for all feed runs exceeded the Tier 1 limit of 100 ppm. The instances that the CO level exceeded the 100 ppm limit caused the system to shut down and a temporary stoppage in sampling. These interruptions cause ambiguities in determining feed rates and hourly rolling averages. The average THC concentration for all feed runs was below the 20 ppm limit.

The metals feed rates for organic Sb, Pb, Ba, Hg and Cr did not exceed limits specified by the permit. Due to feed stoppages, metal feed rates for two runs were below target feed rates.

The average emission rates for Ag, Ba, Be, Cd, Hg, As and Tl were below the Tier II limits.

The Cr emission rate for runs 3 & 4 exceeded the Tier II emission screening limit. The PB emission rate for runs 3 & 5 exceeded the Tier II emission screening limit. The Sb emission rate for run 3 exceeded the Tier II emission screening limit.

With respect to HCB, the DRE for runs 3 & 4 failed while run 5 passed. This appeared to be largely due to the afterburner being operated at 1200° F. It was raised to 1400° F. for run 4 and 5. There was an increase in the DRE as the afterburner temperature was increased. However, due to flame instability at elevated temperatures, the afterburner did not reach high enough temperatures to give confidence in meeting a 99.99 % DRE of HCB for three consecutive runs. With subsequent research it was determined that for proper destruction of HCB, the afterburner temperature should be increased to 1600° F.

RCRA TRIAL BURN TESTS, 9-31 AUGUST 93

The purpose of these tests was to determine if the deactivation furnace met the performance standards for hazardous waste incinerators (HWIs) and to establish operational limits required for a Resource Conservation and Recovery Act (RCRA) Part B Permit for the furnace.

There were 5 test series of waste feeds incinerated during the trial burn tests. They were as follows:

Test Series	Waste Feed
1	0.50 Cal. M17
2 & 3	M1 Propellant/HCB/Metals mix
4	M1 Propellant/Metals mix
5	M7 Propellant/Metals mix

The propellants were placed in paper bags secured with masking tape. The chemicals were also bagged and fed with the propellants in the established proportions. In addition, water was injected into the bagged M1 propellant just before it was fed into the furnace. The water delayed combustion until the propellant was in the center section of the furnace.

The waste feed mixtures were unique to these tests and posed numerous problems and unusual situations during the incineration process. It had been hoped that these mixtures would provide adequate simulation of a broad range of munitions and propellants which would be incinerated in the deactivation furnace. Table 1 on Page 8 of USAEHA's final report lists the test series and waste feed, etc.

Some of the problems and situations which were encountered are as follows:

a. Conveyor jams.

b. During runs 2-1 through 5-3, the kiln and the discharge conveyor were overloaded. The high lead feed rate and a prevailing southerly wind caused the lead to solidify near the discharge end.

Molten lead would back up and when the slug melted, the mass of the lead would overload the discharge conveyor.

c. Sampling train equipment problems such as failed posttest leak checks, broken equipment during transport to the lab, etc.

d. During run 4-3 the accumulated lead from previous and current runs clogged up the discharge conveyor. The run was aborted because it would have been a permit violation to operate the incinerator without a discharge conveyor. This run was repeated a day later.

e. The THC monitor failed to operate for the majority of the Trial Burn. Since the maximum hourly rolling average of CO (corrected to 7% O_2) never exceeded the Tier I limit, the THC data was not needed.

The deactivation furnace met all of the performance standards for HWIs except the destruction and removal efficiency (DRE) of hexachlorobenzene (HCB). The DRE from run 3-1 was 99.985% (see table below). Since one of the three runs did not meet the required DRE, the furnace failed to meet the DRE requirements. Close review of the data concerning run 3-1 showed an afterburner flameout for a period of approx 3 minutes, which probably was the major cause for the DRE not being met. Consequently another Trial Burn Test is being planned. Discussions with the State have been ongoing to insure that another TBT can be performed.

Run No.	HCB In (lb)	Max HCB Out Stack	Max HCB APCS Ash	Max HCB Destroyed
3-1	9.00	0.001377	0.0001368	8.998
3-2	9.00	0.0001101	0.0001368	8.999
3-3	9.00	0.00004497	0.0001368	8.999

The corrected carbon monoxide (CO) 1-hour rolling average for all tests onducted was below the Tier I limit of 100 ppm.

The chromium (Cr) emissions exceeded the Tier II metals emission limit for all metals runs. The lead (Pb) emissions exceeded the Tier II metals emission limit for nine of the eleven metals runs. The cadmium (Cd) emissions exceeded the Tier II metals emission limit for one of the eleven metals runs. Because the Tier II limits for these metals were exceeded (see table below), a Tier III analysis of these metals was initiated by USAEHA to determine if these emissions represent an adverse health impact to exposed individuals.

Emission Rate (g/hr)

Run No.	Chromium (Cr)	Lead (Pb)	Cadmium (Cd)
2-1	0.11374	17.14117	0.01695
2-2	0.09149	17.71738	0.01152
2-3	0.62016	13.01676	0.01867
3-1	0.41909	7.51032	0.01495
3-2	0.25397	0.35458	0.01438
3-3	1.10162	47.87232	0.01487
4-1	---	---	---
4-2	0.26529	40.30065	0.32291
4-3	0.28175	20.57919	0.00852
5-1	0.32012	21.75527	0.02041
5-2	0.10681	24.65242	0.00656
5-3	0.45162	0.04752	0.00575

After the trial burn tests were completed, the problems which had been encountered and not solved during the tests were addressed. The discharge conveyor was modified to include improved trays to handle excessive lead which exited the furnace. The temperature in the afterburner was raised to 1600° F. Program modifications were made to not bypass the baghouse during shutdown, etc.

A USAEHA Tier III analysis final report was provided to TEAD and the State of Utah in April 94. The purpose of this analysis was to demonstrate, through the use of computer modeling, that the maximum annual average off-site ground level concentrations of the metals that exceeded Tier II emission limits during the August 93 Trial Burn (Cadmium, chromium, and lead) did not exceed regulated levels.

Due to varied topography surrounding the furnace, dispersion models for both simple and complex terrain were used. Industrial Source Complex Long-Term 2 (ISCLT2) was used for receptors up to stack height, and the Complex1 model was used for receptors above stack height. Terrain features below stack height and within a 50 kilometer radius assessment area were modeled with the ISCLT2 model. The terrain features above stack height and out to a distance of 10 km were modeled with the Complex1 model.

The results from the Tier III computer modelling indicated that the maximum annual average off-site ground level concentrations of the three metals of concern did not exceed regulated ambient air quality levels. The results are as follows:

Metal	**Model Concentration (micrograms/m^3)**	**Risk Specific Doses (micrograms/m^3)**
Cadmium	0.00004	0.00560
Chromium	0.00014	0.00083
Lead	0.00606	0.9000

The sum of the ratios of the predicted maximum annual average off-site ground level concentrations to the RSD for all carcinogenic metals was 0.178 which is below the 1.0 requirement.

The Tier III analysis, is under review by the State of Utah.

TEAD performed a mini-burn test in July 94. These tests were completed 5-13 July. The results are being prepared by USAEHA. The State of Utah has not yet given approval as to when a Trial Burn Test can be performed.

The Trial Burn Test could be used by other sites to request a Part B permit using the data-in-lieu-of a trial burn test.

CONSTANTLY CHANGING RCRA REQUIREMENTS

Since the Part B permit has been granted for the TEAD Complex, numerous other requirements have been added to those requesting Part B permits. Two of these are Health Risk Assessments(HRAs) and the new guidance to test for Principal Inorganic Constituents (PICs), dioxin and analogous furans. Both of these present major hurdles in obtaining an operating permit for a furnace system, adding upwards of another year and much more expense to the permitting process.

HEALTH RISK ASSESSMENTS

These assessments look at the effect on the entire ecological system near the furnace complex and the impact of the operating furnace on the plants, animals, and human life around the complex, The HRAs necessitate the gathering of enormous quantities of data currently not available. Conservative estimates of the parameters have to be made in place of actual data when not available. USAEHA is requesting funding to conduct and do numerous tests at a permitted facility to acquire needed test data.

PRINCIPAL INORGANIC CONSTITUENTS

According to USAEHA, they have not established data gathering trains to measure dioxin and furans. Much more equipment and time will be needed to gather this data and add it to their test procedures and reports.

CONCLUSIONS

Based upon our experience in dealing with Trial Burn Tests at not only the TEAD furnace site but others such as at Lake City AAP, Iowa AAP and Kansas AAP, the following conclusions have been reached:

a. Site personnel should utilize the 720 hour shake down period to make sure their equipment is running properly and well and that operator personnel are well trained and efficient in operating the equipment.

b. Mini-burn tests should be performed in advance of a Trial Burn Tests (TBT), to establish a coordinated, efficient plan for the TBT and resolve problems, etc.

c. Plan well ahead for the TBT and prepare well in advance for feed stock, equipment, etc.

d. Request that State and Federal EPA agencies consider acceptance of Trial Burn Test data acquired at a tested facility be used in-lieu of doing a full blown trial burn test at a site trying to get a Part B permit.

e. Have USAEHA perform a Tier III analysis for the site needing a Part B permit.

f. Try to keep informed of the more stringent requirements that are being imposed on the sites seeking Part B permits such as HRAs, testing for dioxin and analogous furans, etc.